

CLAIMS

We claim:

- 5 1. An apparatus for threading a biopolymer through a nanopore, comprising:
- (a) a first microfluidic channel having at least two electrodes for creating an
 electric field for creating electrophoretic movement of the biopolymer in a
10 first direction;
- (b) a nanopore in the wall of the first microfluidic channel; and
- (c) a second microfluidic channel communicating with the first microfluidic
15 channel by way of the the nanopore in the wall of the first microfluidic
 channel, the second microfluidic channel having a second set of electrodes
 for creating a eletrophetic movement of the bipolymer in a second
 direction.
- 20 2. An apparatus for threading a biopolymer through a nanopore, comprising:
- (a) a substrate having a channel wall and a nanopore in the channel wall, the
 channel wall and nanopore being designed for receiving a biopolymer;
- 25 (b) means for moving the biopolymer toward the nanopore in a first direction;
 and
- (c) means for threading the biopolymer through the nanopore in a second
 direction.
- 30 3. An apparatus for threading a biopolymer through a nanopore, comprising:
- (a) a substrate having a channel wall and a nanopore in the channel wall, the
 channel wall and nanopore being designed for receiving a biopolymer;
- 35 (b) at least one set of electrodes for moving the biopolymer in a first direction
 past the nanopore; and
- (c) at least one set of electrodes for moving the biopolymer in a second
 direction through the nanopore after the biopolymer has been moved past
 the nanopore.
- 40 4. An apparatus as recited in claim 3, wherein the biopolymer comprises a
 polynucleotide.
5. An apparatus as recited in claim 4, wherein the biopolymer comprises a leader
 molecule attached to the biopolymer for threading the biopolymer through the
 nanopore.

- 5 6. An apparatus as recited in claim 5, wherein the leader molecule comprises at least one fluorophore.
7. An apparatus as recited in claim 4, wherein the polynucleotide is double stranded.
- 10 8. An apparatus as recited in claim 4, wherein the polynucleotide is selected from the group consisting of mRNA, DNA, double stranded DNA, double stranded RNA, tRNA, and mDNA.
- 15 9. An apparatus as recited in claim 3, further comprising a second channel communicating with the first channel by way of the nanopore.
- 20 10. An apparatus as recited in claim 9, wherein the second channel is orthogonal to the first channel wall.
11. An apparatus as recited in claim 9, wherein the second channel is below the first channel wall.
- 25 12. An apparatus as recited in claim 9, wherein the second channel wall is adjacent to the first channel wall.
13. An apparatus as recited in claim 9, wherein the second channel is above the first channel wall.
- 30 14. An apparatus as recited in claim 1, wherein the first channel diameter is from 1 to 10 micrometers.
- 35 15. An apparatus as recited in claim 1, wherein the first channel wall is from 1 to 10 micrometers in width.
- 40 16. A method of threading a biopolymer through a nanopore, comprising:
 - (a) moving the biopolymer with a leader molecule past the nanopore in a first direction; and
 - (b) threading the biopolymer through the nanopore in a second direction.
- 45 17. A method of threading a biopolymer through an apparatus as recited in claim 1, comprising:
 - (a) moving the biopolymer past the nanopore in a first direction; and
 - (b) threading the biopolymer through the nanopore in a second direction.

18. A method of moving a biopolymer having a leader molecule through a nanopore in a substrate, comprising:

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(a) applying a first electrophoretic field in a defined direction to move the leader molecule past the nanopore in the substrate until a portion of the biopolymer is adjacent to the nanopore; and

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(b) applying a second electric field in a second direction to move the biopolymer in a second direction through the nanopore.

19. An apparatus as recited in claim 9, wherein the apparatus is transparent so that light may be used to detect the fluorophore and its position in the first channel.

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20. An apparatus as recited in claim 9, wherein the apparatus is transparent so that light may be used to detect the fluorophore and its position in the second channel.

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